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Does the Bobath/ neurodevelopmental technique (NDT) improve gait quality in acutely post stroke individuals?

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Title: Does the Bobath/ neurodevelopmental technique (NDT) improve gait quality in acutely post stroke individuals?

Clinical Scenario: My patient was an 80-year-old gentleman who was admitted to the inpatient rehabilitation unit one week after sustaining a right cerebral vascular accident (CVA). He presented with impairments including right-sided weakness, left-sided inattention and left visual field cut. He was able to ambulate five steps in the parallel bars with moderate assistance. The patient had been admitted seven days prior when his wife brought him into the Emergency Department with slurred speech. Tissue Plasminogen Activator (TPA) was administered shortly after his arrival at the hospital. The patient's wife reported this was his first stroke.

Brief Introduction: Bobath Method or Neurodevelopmental Technique (NDT), introduced in 1987, is a popular program for stroke rehabilitation. The theory explains that damage to the central nervous system (CNS) causes neurophysiological dysfunction, which results aberrant movement patterns, but that neuroplastic changes can to restore normal movement. The therapists analyze the patient's alignment, limit abnormal muscle tone, observe how the key points of the body move relative to another, and facilitate desired movement.

The inpatient rehabilitation unit has a high population of recovering stroke patients. To qualify for inpatient rehabilitation according to Medicare, a patient must need ongoing therapy from two or more disciplines including physical therapy, occupational therapy, and speech-language pathology, the patient must participate in 3 or more hours of daily therapy, and require a physician three or

more times a week (Centers for Medicare & Medicaid Services, 2014). The national average length of stay is 13 days with pressure from insurance agencies to prepare for the patient's discharge home as quickly as possible (Report to the Congress: Medicare Payment Policy, 2011). The short stays place a high demand for physical therapists to utilize the best, and most time efficient interventions as possible. After working in this environment, my question is as follows: Is NDT more effective than conventional therapy at increasing patients walking ability?

My Clinical Question: Does NDT increase the quality of gait in individuals who have had a recent stroke greater than standard physical therapy including treadmill walking and task specific exercises?

Clinical Question PICO:

Population**:** Individuals acutely post-stroke in an inpatient rehabilitation unit.

Intervention: The intervention is the NDT method of treatment.

Comparison: The comparison is standard physical therapy including treadmill walking and task oriented exercises.

Outcomes: The components of gait including velocity, step symmetry, and distance in addition to the ability to perform pre-gait activities.

Overall Clinical Bottom Line: Based on the results of Vliet et al, Eich et al, Brock et al, and Dias et al, there is moderate evidence to say that NDT is equally as effective as standard therapy in individuals who have sustained their first stroke in the previous year or less in improving gait quality, ability to perform pre-gait activities, and balance. NDT and all of the comparison methods produced

relatively significant within group results with scattered between group differences. Treatment initiation ranged from two weeks to 12 months post-stroke and treatments lasted from two weeks to six weeks. Results from the treatments tended to be equally effective in the range of chronicity of stroke. Outcomes used to reach this conclusion were the Berg Balance Scale, Rivermead Motor Assessment, Rivermead Motor Index, Movement Assessment Scale, six minute walk test, and ten meter walk test, all of which were found to be reliable and valid measures.

All studies had good to fair internal validity. Threats across the board included lack of therapist and subject blinding. External validity was fair overall as most of the studies were initiated greater than two weeks after initial stroke diagnosis when inpatient rehabilitation would usually occur. Most of the NDT treatments were not described in enough detail for a clinician to reproduce the techniques. Also, most studies had small sample sizes with limited power, reducing the ability to generalize to other individuals one-week post CVA.

On a cost benefit analysis NDT certification requires a significant amount of therapist time but is not as expensive as the initial purchase of a treadmill or gait trainer equipment (British Bobath Tutors Association, 2014). Most the studies were feasible with insurance reimbursement in an acute rehabilitation unit, and feasible for patients as well. Treatments were found to be safe with no adverse reactions reported. Three out of the four studies had high subject retention indicating patients found participating tolerable in general.

Search Terms: NDT/Bobath method, gait training, rehabilitation, and stroke

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Rational For Article Choice: A literature review was performed using the search terms above in the PubMed, Medline, PEDro, and CINHAHL databases. All seemingly relevant articles were flagged for a thorough review. The references were reviewed in the randomized controlled trials as well as the literature reviews for additional relevant articles. This process revealed nine trials whose hypothesis were directed toward the efficacy of NDT versus other standard physical therapy treatment. The articles reviewed in this paper were chosen for their PEDro score as determined by the website and personal evaluation, as well as those with the most relatable intervention comparisons and outcome measures (Physiotherapy Evidence Database, 1999). The four articles chosen for this study and a comparison of PEDro scores are:

1. Vliet, PM van, Licoln, N.B., Foxall, A. Comparison of Bobath based and movement science based treatment for stroke: a randomized controlled trial. *Journal of Neurology, Neurosurgery, and Psychiatry*. 2005; 76:503-508
2. Eich, H.J., Mach, H., Werner, C., Hesse, S. Aerobic treadmill plus Bobath walking training improves walking in subacute stroke: a randomized controlled trial. *Clinical Rehabilitation.* 2004; 18: 640-651
3. Brock, K., Haase, G., Rothacher, G., Cotton, S. Does physiotherapy based on the Bobath concept, in conjunction with task practice, achieve

greater improvement in walking ability in people with stroke compared to physiotherapy focused on structured task practice alone? A pilot randomized controlled trial. *Clinical rehabilitation.* 2011; 25(10) 903-912

4. Dias, D., Lains, J., Pereira, A., Nunes, R., Caldas, J. et al. Can we improve gait skills in chronic hemiplegics? A randomized control trial with gait trainer. *Clinic of Physical Medicine and Rehabilitation.* 2007; 43: 499-504

Tables 1 and 2 show a comparison of the four articles with regard to PEDro scores and study parameters (Physiotherapy Evidence Database,1999)

Table 1. Comparison of PEDro Scores

	Vliet et al. 2005	Eich et al. 2004	Brock et al. 2011	Dias et al. 2007
Random	yes	yes	yes	yes
Concealed Allocation	yes	yes	yes	yes*
Baseline Comparability	yes	yes	yes	yes
Blind Subjects	x	x	x	x
Blind Therapists	x	x	x	x
Blind Assessors	yes	yes	yes	yes*
Adequate Follow up	x	yes	yes	yes
Intention to Treat	yes	yes	x	x
Between Group Comparison	yes	yes	yes	x
Point Estimates & Variability	yes	yes	yes	yes
Total Score	7/10	8/10	7/10	6/10 *

*Score reflected is different from the PEDro website

Table 2. Comparison of selected article PICO

	Vliet et al.	Eich et al.	Brock et al.	Dias et al.
Population	-120 patients -<2 weeks post stoke - Unknown inpatient or outpatient rehab	-50 patients -<6 weeks post stroke - Inpatient rehab	-20 patients -4- 20 weeks post stoke - Inpatient and outpatient rehab	-40 patients -12 months post stroke
Intervention	NDT	NDT	NDT plus task practice	NDT
Comparison	Movement Based Science	NDT and Treadmill	Task Practice	Gait trainer
Dosage	-23 minutes -5x a week -3 weeks	-60 minute -5 x a week -6 weeks	-60 minutes -6 sessions - >2 weeks	-40 minutes -5x week -5 weeks
Outcome Measure	-Rivermead Motor Assessment -6 meter walk -Motor Assessment Scale	-6 minute walk test -10 meter walk -Walking quality by Rancho Los Amigos	-Modified 6 minute walk test -10 meter walk -Berg Balance Scale	-Rivermead Motor Index -6 minute walk test -Berg Balance Scale -10 meter walk
Significance	None	Some	Some	Within group

Article 1: Vliet, PM van, Licoln, N.B., Foxall, A. Comparison of Bobath based and movement science based treatment for stroke: a randomized controlled trial. *Journal of Neurology, Neurosurgery, and Psychiatry*. 2005; 76:503-508

Clinical Bottom Line: Based on 120 patients who had a stroke, NDT is not superior to the task practice approach of Movement Science Based (MSB) at improving gait speed or pre-gait tasks. Outcomes used for these conclusions were from the Rivermead Motor Assessment (RMA), Motor Assessment Scale (MAS), and Six-meter walk test (6MWT). Threats to the internal validity of the study were high study losses of 27%, and a lack of blinding of the subjects and therapists. The threat to the external validity was the poor description of the treatment sessions.

Article One PICO:

Population: The authors studied 120 subjects, mean age of 74 years, who were 14 days or less post-stroke when admitted to an inpatient rehabilitation unit.

Intervention: Subjects in the treatment group were treated with NDT therapy for as long as was needed, an average 23 minutes five days a week for three weeks.

Comparison: Subjects in the control group were treated with MSB therapy for as long as was needed, on average 23 minutes five days a week for three weeks.

Outcomes: The outcomes included one, three, and six-month assessments with the RMA, MAS, ten hole peg test, 6 MWT, Modified Ashworth Scale, Nottingham Sensory Assessment, Barthel Index, and Extended Activities of Daily Living Scale. Outcomes relevant to my study came from the RMA, MAS, and 6MWT. Other outcome measures were performed but are not included in this paper.

Blinding: The subjects and therapists were not blinded to group allocation since the patients could see what therapy they were participating in, and the therapists knew what treatment they were providing. Blinding of these parties would have been difficult. However, the lack of blinding serves as a minor threat as there is a chance for Hawthorne and Rosenthal effects. The Hawthorne effect is when a subject acts differently when they know they are being studied and the Rosenthal effect is when a subject performs better because they know improvement is

expected. Conversely, the assessor for the one, three, and six-month assessments was blinded to group allocation.

Controls: The control group received MSB therapy. The article did not describe treatment details but did cite a reference for the theory behind the control group's exercise program. The reference explained it was rooted in systems theory that states in order to understand how a body moves one needs to understand the external forces that act upon it and is entirely task oriented training in nature. This seems like a valid control because conventional therapy often includes task practice.

Randomization: The researchers utilized blocked computer randomization to place the participants into their perspective groups. The allocation was concealed in opaque envelopes. The randomization was successful as the groups were similar at baseline. However, the NDT group had higher scores on some sections of both the RMA and MAS at baseline that was not statistically significant.

Study: This was an assessor blinded, randomized controlled trial. The baseline data for the 120 participants was gathered within two weeks of stroke onset. They were eligible to participate if they were referred to physical therapy and did not meet the exclusionary criteria. These exclusionary criteria were: unconscious on admission to the hospital, unable to toilet independently prior to their stroke, lived greater than 25 km from the hospital, unable to handle the physical tasks in the initial one half hour assessment, or failure to sign informed consent.

Each group participated in their perspective therapies for a median of 23 minutes per day, five days a week, for as long as was needed. Each patient was

treated on average for three weeks. The NDT therapists only treated the experimental group using the NDT guidelines, main concepts, and objectives, while the MSB therapists exclusively treated the control group using their theoretical framework. Outcome assessments were performed at one, three, and six months after randomization by a blinded assessor.

The outcomes relevant to this review include RMA, MAS, and 6 MWT. The authors did not address validity or reliability of these outcome measures, however they did cite other studies that used these outcome tools. An independent literature review found these measures to be reliable, valid, and responsive in stroke populations (Kurtais, 2009, Salbach 2001, Poole, 1988). There are no known gold standards to measure quality or quantity of gait parameters in stroke or healthy individuals. In the literature, the 10-meter walk test has an MCID of 0.16 m/s (Rehabilitation Measures Database*, 2010*). Since the 6MWT also measures velocity, it is safe to use 0.16 m/s as a guideline.

This study lost several individuals through the course of the trial. At the one-month assessment, eight were lost from the NDT group and 13 from the MSB group. This represents a 17.5% loss. About half the losses from each group were due to illness. Other reasons for study losses were: five deaths, four refusals, and three unknown. At the three-month time point an additional nine were lost from the NDT group and five from MSB group. Reasons included: illness, death, and refusals or failures to return for assessment. At the six-month mark, 45 remained in the NDT group and 42 in the MSB. This represents a total loss of 27.5% of participants. The losses do not seem related to the treatment

because the initial 60 subjects in both groups completed the three weeks of treatment. All patients were analyzed in the group they were originally allocated to and all data appears accounted for. An intention to treat was performed because greater than 15% of participants were lost. When greater than 15% drop from the study there is a risk for bias as those who were not analyzed may be systematically different from those who were analyzed.

Internal Validity: The internal validity is judged to be good. The patients were randomized into test or control groups and were not significantly different at baseline. The subjects and therapists were not blinded, but both groups were getting a treatment. The Hawthorne and Rosenthal effects potentially compromise the validity, but the perceived threat is deemed to be minor. The therapists had been treating patients with their perspective treatment styles, NDT or MSB, before the initiation of the study, and therefore believed their treatments worked. The assessor was successfully blinded. His attempt to determine which group based on his assessment after the intervention did not correlate well with their actual group assignment. The outcomes used were all reliable and valid. To counter the large loss of participants to follow-up, an intention to treat was performed. Therefore, the only threats to the internal validity of the study are Hawthorne and Rosenthal effects.

A power analysis was also performed and determined that 78 participants were needed to demonstrate a meaningful difference of two points on the RMA. A total of 87 participants completed the trial, so we can be comfortable

concluding that there were enough participants to demonstrate a difference, if any, immediately after treatment or after six months post.

Evidence: The results are presented from the "Trunk and Leg portion" of the RMA (Table 3), "Walking section" of the MAS (Table 4), and 6 MWT (Table 5) as reported from the article. Both the RMA and MAS measure the consequence of motor impairment in terms of mobility. The RMA has ten individual items from transferring from supine to sit to challenged walking. Each item is scored with a zero if the individual is unable to perform the task, or a one if able to complete the task. MAS scored from a one - six and are based on the ability to walk specified distances with dynamic challenges. Higher scores indicate better performance. In the 6 MWT an individual would walk for 6 meters (m) as quickly as they could to determine their gait velocity.

Table 3: Rivermead Motor Assessment (RMA), Legs and Truck Section and Gross Motor Section at baseline, one, three, and six months. The RMA is scored 0-10 with 10 being highest function Results using a Mann Whitney U test comparing Bobath (NDT) to Movement Science Base (MSB)

RMA: Legs and Trunk	Baseline	1 month	P value	3 month	P value	6 month	P value
NDT	4	7	.61	7	.52	7	.41
MSB	2	5		7		7	
RMA: Gross Motor							
NDT	2	7	.49	7	.18	8	.61
MSB	1	6		8		8	

No raw data was given to create personal calculations. The evidence was compared using a Mann Whitney U test. The results are based off an Intention to Treat Analysis. P values were set at an alpha level of .05. An alpha of .05 means 95% confidence that there is a difference between the groups when the P value is smaller than .05.

Table 4: Movement Assessment Scale (MAS), Walking section comparison at Baseline, one, three, and six months. Test is scored 0-6 with 6 being the highest function. Results using a Mann Whitney U test comparing Bobath (NDT) to Movement Science Base (MSB)

MAS: Walking	Baseline	1 month	P value	3 month	P value	6 month	P value
NDT	0	3	.28	3	.55	4	.27
MSB	0	3		4		3	

The 6 MWT did not have baseline results, because neither group was able to walk according to the MAS. The MCID for the 10-meter walk test (10 MWT) is .16 m/s. If we use the MCID from being unable to walk in either groups, with .66 in the NDT and .60 for MSB at one month, both groups met the MCID.

Table 5: 6 meter walk test (6 MWT) velocity results in m/s at one, three, and six months. Results calculated using a Mann Whitney U test comparing Bobath (NDT) to Movement Science Based (MSB)

6 MWT	1 month	P value	3 month	P value	6 month	P value
NDT	.66	.66	.69	.87	.76	.54
MSB	.60		.64		.64	

The results found no significant difference between NDT and MSB at any of the time intervals for any of the relevant outcome tools. Therefore according to this study, NDT is neither a more or less effective method than MSB at increasing gait speed or the ability to perform pre-gait tasks.

Applicability of study Results:

Benefits vs. Cost: There is no additional equipment or time needed for NDT or MSB treatments. There is an extra expense of approximately $3,000 and about 4 months time required of the therapist in acquiring the NDT certification (BBTA British Bobath Tutors Association*, 2014*). Each requires the same amount of therapist and patient time. In this study the NDT participants spent more time with a physical therapist assistant (PTA) with a PT present, but the MSB group

spent more time with the PTA alone. There were no noted adverse events in either treatment group.

Feasibility of treatment: The treatments were not described in enough detail to replicate the study. The only assumption the reader could make was the therapists were treating with the method (NDT/ MSB) they were most comfortable with. The therapists reviewed the frameworks of their perspective methods, and were instructed to treat in that manner.

The authors were vague as to whether the patients were treated in an inpatient or outpatient setting. The median session length of 23 minutes was provided with the median of three weeks of treatment. The amount of time spent with the patient was feasible given average insurance reimbursement for acute rehabilitation facilities. The treatment of 23 minutes is tolerable by the patients as demonstrated by no participants being lost during the three weeks of treatment.

Summary of external validity: Because the treatment sessions were not described in detail, it would be hard to directly replicate the methods. The large number of study losses makes extrapolation difficult. It is unknown if the treatments caused a large number of participants to fail to comply. Also, it is unknown if they were being treated as inpatients or outpatients and thus would be less applicable to inpatient facilities if subjects were treated as outpatients. For these reasons the external validity is deemed fair.

The distribution of participants is similar to the patients seen in an acute rehabilitation ward. A power analysis was performed and the number of

participants in the study was high enough to determine if there was a difference between treatments if one existed.

Article Two: Eich, H.J., Mach, H., Werner, C., Hesse, S. Aerobic treadmill plus Bobath walking training improves walking in subacute stroke: a randomized controlled trial. *Clinical Rehabilitation.* 2004; 18: 640-651

Clinical Bottom Line: Bobath gait training plus treadmill training (NDT +T) for 60 minutes was found to significantly increase walking velocity and capacity in 50 moderately affected patients who survived first time supratentorial stroke six week prior, than NDT gait training alone. Both groups received therapy for 30 sessions and were assessed immediately post treatment and again after three months. NDT +T increased .31 m/s (+/- .30) compared to NDT alone at .16 (+/- .22) from baseline after treatment for walking velocity. Walking capacity was increased 90.6 m (+/- 43.5) for NDT +T and 55.7 (+/- 32.6) for the NDT only group at six weeks. The significant difference was maintained at three months for both outcomes. Both groups met the MCID of .16 m/s for velocity using 10 MWT and capacity for walking during a six-minute walk test (6 min. test) of 50 feet.(Note, the 6 min. test is different than 6 MWT). The groups were not different in the RMA gross motor assessment or in walking quality. The minor threats to internal validity include lack of blinding to the therapists and subjects; the minor threat to external validity is the vague description of treatment for the NDT group.

Article Two PICO:

Population: There were 50 individuals who had their first stroke within the prior six weeks, resided on a rehabilitation unit, and ambulated a minimum of 12 meters.

Intervention: The participants completed a 60-minute session of NDT treatment five days a week for a total of six weeks.

Comparison: The participants in the comparison group received 30 minutes of treadmill training plus 30 minutes of Bobath treatment five days a week for a total of six weeks.

Outcomes: The patients were evaluated on their walking velocity by a 10 MWT, walking capacity by a six min. test, the gross motor section of the RMA, and walking quality as outlined by Rancho Los Amigos (RLA).

Blinding: The subjects and therapists were not blinded. Conversely, the assessor was blinded to group allocation during all assessment points. The lack of blinding serves as a minor threat as there is a chance for Hawthorne and Rosenthal effects.

Controls: One group, NDT + T, received 30 minutes of treadmill training and 30 minutes of NDT. The other group, NDT only, received 60 minutes of NDT driven gait training. The single difference in treatment makes it very easy to attribute the differences in outcome found to the substitution of treadmill training.

Randomization: An independent person who chose from sealed envelopes randomized the participants immediately prior to intervention. A total of 25 participants were in both groups. Randomization was successful as there was no significant difference found between the groups at baseline.

Study: This study was an assessor blinded, randomized controlled trial. Individuals were eligible if: they were 50-75 years old, status post first time supratentorial stroke, less than 6 weeks post-stroke, able to walk 12 m with standby assistance, moderately affected with a Barthel index of 50-80, willing to participate in a 12-week rehabilitation program, cardiovascularly stable, having no other neurologic or orthopedic impairments, and able to understand the purpose of the study. If the inclusion criteria were met, participants were guided in their treatments for 60 minutes, five days a week, for six weeks. The experimental group received 60 minutes of NDT walking rehabilitation with pre-gait activities, tone-inhibiting facilitation, over ground walking, and stair training. The control group received 30 minutes of the above NDT therapy and 30 minutes of treadmill training. The patient's body weight was supported from 0% to 15%. The treadmill was paced and inclined in a manner in which the patient's heart rate stayed at an appropriate level as determined by the Karvonen Method: [Target Heart Rate= ((max heart rate- resting heart rate) x % intensity) + resting heart rate].

The outcomes used for this study were 10 MWT, 6 min. walk test, the gross motor section of the RMA and a walking quality assessment using RLA. The 10 MWT was performed twice with the average time recorded. The study authors did not report on quality of the tool, but independent search found excellent inter-rater reliability, a standard measurement of error at .06, and an MCID of .16 m/s (Rehabilitation Measures Database, 2010). The 6 min test was performed one time with short breaks being allowed, but longer pauses were

cause to stop the assessment and record distance. The study researchers did not comment on the validity or reliability, but an independent search found it to be both with an MCID of 50 meters in stroke populations (Rehabilitation Measures Database, 2010). The RMA was found by an independent search to be reliable and valid with no MCID (Kurtais, 2009). The walking quality assessment gave zero to three points for 14 items based on normal movement as described by RLA. The study authors reported a test- retest reliability of .87. No other reliability/ validity data was found on an independent search. There is no known gold standard for measuring gait capacity, velocity, walking quality or ability to perform pre-gait activities.

The study began with 25 participants in each group. All 50 were treated for six weeks with no losses. At the three-month assessment after treatment had concluded, one participant in the experimental group refused to follow up. This represents a 2% loss. All subjects were evaluated in the group they were allocated to. An intention to treat analysis was performed. There does not appear to be any missing data, nor does the one loss seem related to the intervention.

Summary of internal validity: This study was judged to have good internal validity. This was a randomized controlled study, the assessors were blinded, and the subjects were similar at baseline. Most outcome tools were reliable and valid, there were few study losses, and an intention to treat was performed. The threats to internal validity were Hawthorne and Rosenthal effects because the subjects and therapists were not blinded. These threats are deemed to be minor because the subjects did not know which treatment is believed to be superior,

and the therapists provided quality treatment to both groups. No power analysis was performed so it is unknown if the number of participants was enough to demonstrate significance.

Evidence: The data from all four-outcome measures used at the end of the six-week treatment and at the three-month assessment are relevant to this review. The NDT +T group was found to walk significantly faster than the NDT only group at the end of six weeks of treatment and at three months as shown by Table 6. There was an increase of .31 m/s in the NDT + T group while the NDT only group increased .16 m/s. Both groups did meet the MCID of .16 m/s. The NDT + T group shows a medium effect size of .42 with a Confidence Interval (CI) ranging from -0.014- +0.98. The CI crossing zero suggests if the study were to be repeated, NDT only group may be found to be more effective. At three months, the change in NDT + T group velocity was .36 m/s from baseline while the NDT only group decreased one m/s from the six week mark. Numbers presented in Table 6 were transposed from the study while effect sizes were derived on independent calculation.

Table 6: Walking velocity as determined by the 10 meter walk test

Treatment Group	Baseline	6 weeks	Between group	3 months	Between group
NDT (m/s)	.44 (+/- .22)	.60 (+/- .22)		.58 (+/- .22)	
NDT+ Treadmill (m/s)	.40 (+/- .17)	.71 (+/- .30)		.77 (+/- .35)	
Between Group Comparison			F = 12.6 Significant <.001		F= 15.9 Significant <.001

Table 7 depicts the significant difference between the NDT + T group over NDT only group in walking capacity in six minutes at the end of treatment period

and at three months. The NDT + T group had a change score of 90.6 meters while the NDT only group increased by 55.7 meters. This demonstrates a medium effect size of .45. The CI ranges from -.11 – 1.01, which indicates the study results could be opposite if repeated. At three months, distance walking dropped one m in the NDT only group and continued to increase 26 meters in the NDT +T group. The MCID for the 6 min. test in stroke populations was found to be 50 m and both groups met the cut off (Rehabilitation Measures Database*, 2010*).

Table 7: Walking capacity as determined by the 6 minutes walk test

Capacity (meters)	Baseline	6 weeks	Between group	3 months	Between group
NDT	108 (+/- 60.1)	164.4 (+/- 69.3)	F = 10.3	163.0(+/- 70.2)	F= 18.7
NDT+ Treadmill	108.1 (+/- 50.8)	198.8 (+/- 81.1)	Significant P= .002	224.8(+/- 90.0)	Significant P < .001

Tables 8 and 9 portray the results from the RMA gross motor section and walking quality. There were no significant differences found at six weeks or at three months between the groups.

Table 8: Gross motor function of Rivermead Motor Assessment scored 0-13

RMA gross motor	Baseline	6 weeks	Between group	3 months	Between group
NDT	9 (6-10)	11 (10-11)	no	11 (10-11)	no
NDT+ Treadmill	9 (7-10)	11	significant	11	significant

Table 9: Walking Quality as outlined by Rancho Los Amigos 14 items scores range 0-41

Walking Quality	Baseline	6 weeks	Between group	3 months	Between group
NDT	19 (15-23)	24 (19-29)	No	23.5 (11.3-29.8)	no
NDT+ Treadmill	18 (15-24)	24 (18-27)	significant	24 (19-30)	significant

Applicability of study results:

Benefits vs. Costs: The treatments were similar in the amount of therapist and patient time, neither group had an adverse event, and both groups reached the prospective MCIDs. However, the costs of the interventions and outcomes were different. NDT +T was found to have significant results over NDT only group in increasing walking velocity and capacity, but at a large cost. NDT certification is expensive for the therapist as discussed previously, but supported treadmill training has additional investment. While most participants did not need body weight support, the machine can cost $12,000 plus $4,000 for the treadmill (Technology for Long-Term Care, 2010). The cost may be worth the increased benefit received from NDT +T.

Feasibility: The amount of daily therapy relates well with inpatient rehab and should be fairly easy for patients to tolerate. However, the 30-day stay is twice the typical length of stay for an inpatient at present (Report to the Congress: Medicare Payment Policy, 2011). Many rehabilitation units are equipped with supported treadmill training and NDT certified therapists. The treatment had no adverse events and is not dependent on patients practicing on their own. The downfall was that the NDT only treatments were not described thoroughly. Although, the NDT treatments were described with minor detail, there is still not enough information to repeat the study.

Summary of external validity: The internal validity does not compromise the ability to extrapolate to other populations. The study only included supratentorial strokes, with moderately affected patients who were younger in age, which limits

the applicability of the results. It is unlikely that many patients would be authorized to stay for four weeks to receive 30 sessions of therapy.

Article Three: Brock, K., Haase, G., Rothacher, G., Cotton, S. Does physiotherapy based on the Bobath concept, in conjunction with task practice, achieve greater improvement in walking ability in people with stroke compared to physiotherapy focused on structured task practice alone? A pilot randomized controlled trial. *Clinical Rehabilitation.* 201; 25(10) 903-912

Clinical Bottom Line: Based on 26 individuals who sustained a stroke 20 weeks prior to entering the study, six treatments of NDT over two weeks works better at improving gait velocity in a 10 MWT than task practice. The effect size was .7 indicating a moderate effect. The task group received repeated strengthening exercise and practiced challenged walking for dosage-matched treatments with verbal, but without hands-on, feedback from the therapists. There were no significant differences in adapted six min. test or BERG Balance Scale (BBS). Only the NDT group however met the MCID for the 6 min test of 50 m. The minor threats to the internal validity of the study were the lack of blinding of the patients and therapists yielding a fair to good external validity due to the questionable power of the study.

Article Three PICO:

Population: This study included 26 participants who were four -20 weeks post-stroke and were able to ambulate with supervision.

Intervention: The intervention was six one-hour NDT sessions geared toward walking including ten minutes of task practice.

Comparison: The control group received six one-hour sessions of task practice focusing on endurance and dynamic balance and walking.

Outcome: Progress was determined by an adapted six min. test utilizing a ramp, step, and a foam compliant surface, BBS, and walking velocity.

Blinding: The subjects and therapists were not blinded to group allocation, which is difficult to do in therapy research. However, the lack of blinding serves as a minor threat as there is a chance for Hawthorne and Rosenthal effects. Conversely, the assessor was blinded to group allocation during all assessment points thereby avoiding rater bias.

Controls: The control group had six, one-hour sessions of focused task practice. Therapists provided feedback on the performance of tasks, but did not provide hands-on guidance. Half the sessions included repetitive exercises on gym equipment, and the second half was outside walking on ramps, steps, and rough surfaces. This serves as an adequate comparison as the intervention is similar to standard therapy; however, therapists would usually provide tactile feedback and assistance.

Randomization: The randomization was computer generated and stratified according to the interval of time from stroke onset to participation in the study. This is an appropriate stratification. Opaque envelopes concealed the allocation of groups. Randomization was deemed successful since the groups were similar at baseline.

Study: This was a single blind, randomized control trial including 29 subjects. Participants were eligible for inclusion if they had a stroke four - 20 weeks prior to

trial commencement, were currently enrolled in a rehabilitation program, and able to walk five meters indoors. The exclusionary criteria included independent ambulation, pre-morbid household only ambulation, unable to follow single verbal commands, and movement disabilities caused by a non-stroke diagnosis.

The experimental group received NDT treatment by NDT certified therapists to facilitate normal, efficient, and functional movement strategies geared toward walking. Approximately ten minutes of each session was spent on structured task practice. There were six treatments total lasting one hour, over two weeks. The control group received the same number and duration of treatments, but focused on therapeutic exercise on gym equipment and dynamic and challenge walking outdoors.

Outcome measure: The main outcome measure utilized in this study was the 6 min test including a 1:6 ramp, a 160 mm step, and 1.1 meter long firm foam mat. The researchers did not report on the validity for this modified six min. test, but did state the test- retest reliability was .98. On an independent literature review, the six min. test was found to be reliable and valid with an MCID in stroke populations of 50 feet (Rehabilitation Measures Database, 2010). This MCID is applied with caution given the study used a highly modified version.

Other outcome tools included the BBS and 10 MWT. Both were reported by the authors to be reliable and valid. There is no established MCID for the BBS, but the minimal detectible change (MDC) for stroke populations is 3 (Rehabilitation Measures Database, 2010). The cut off score for safe independent ambulation is 45/56 (Rehabilitation Measures Database, 2010). The

10 MWT MCID for velocity is .16 m/s (Rehabilitation Measures Database, 2010). Ambulation slower than .4 indicated household ambulation only. Velocity above .8 indicates the ability for community ambulation.

Study losses: Three participants were lost during the course of the study. The NDT group lost two with an early discharge, and one from the task practice group due to illness. The study losses do not appear to be related to the interventions. This is less than a 15% study loss.

Summary of Internal Validity: This study was judged to be good. The participants were randomly allocated to either an experimental group or a control group to protect from statistical regression, selection, inter-subject differences, history, and maturation. The assessor was blinded protecting from rater bias. Four minor threats exist including Rosenthal and Hawthorne effects, not all outcomes were valid, and no intention to treat analysis was performed. The modified six min. test has face validity, but none officially proven. This is minor, as the other outcome measures have been shown to be reliable and valid. An intention to treat analysis was not performed, however, all participants were analyzed in the group they were randomized into. This study was underpowered as reported by the authors and therefore it may be difficult to show a difference, even if one exists.

Evidence: Assessments were performed on the subjects before and after the two- week intervention period. Table 10 outlines the scores pretest and posttest for both groups as detailed in the study. There were no significant differences found between the groups either before or after the treatments for the modified

six min. test and BBS. However, velocity was significantly increased in NDT group over the task practice group. A self calculated effect size was determined to be .7 that is indicative of a medium to large effect. However, the CI ranges from -.06 to 1.53 meaning if the study was repeated, it would be possible that the results could be reversed.

Table 10: Pre and post intervention outcome results

	NDT Pre	NDT Post	P Value	Task Pre	Task Post	P Value	Between Group
Adapted 6 min. (m)	102.6 +/- 64.5	192.5 +/- 113.5	<.01	78.5 +/- 61.3	119.5 +/- 80.2	<.01	.07
Velocity (m/s)	.51 +/- .27	.94 +/- .47	<.001	.44+/- .32	.60 +/-. 47	<.02	.01
BERG	40.2 +/- 6.1	47.3 +/- 4.6	<.001	43.3 +/- 5.7	47.4 +/-5.0	<.01	.2

Both groups had significant within group changes for all outcome measures. Only the NDT group had a greater than the MCID of a 50 meter increase for the adapted six min. Both groups increased by .16 m/s meeting the MCID for the six min. test. Both groups reached the cut off score of 45/56 on the BBS assessment thereby decreasing their fall risk.

Applicability of Study Results:

Benefits vs. Costs: The frequency of treatment in this study was significantly less than in other studies in this review thereby being financially conservative for the patient by requiring fewer copays. Both groups received the same amount of patient and therapist time, although the task practice group received less hands-on time. No adverse events were noted in either group. The therapist in the experimental group was NDT certified. Treatment with NDT did produce significantly better between group changes in velocity, but not in the adapted 6

min group or BBS. The task practice group carried low cost because all equipment needed would be at a local gym or in a physical therapy clinic. Feasibility of treatment: There were a total of three one-hour treatments per week. This is significantly less physical therapy than the patients would receive in a rehabilitation unit. However, the total treatment lasted two weeks, which is quite comparable to a typical rehabilitation unit stay and reimbursable by insurances. The two treatments were described in greater detail than the previous studies and would easily be reproducible. There was no home exercise program, so compliance would not be an issue. The treatment was not painful for the patients. Summary of external validity: The external validity was deemed fair to good. The underpowered sample size of 26 challenges one's ability to extrapolate to other populations of stroke survivors as such a small sample may not accurately represent the greater population. However, the study had good internal validity, the researchers used a strict protocol and appropriate statistical tests. Therefore the results can be cautiously applied to individuals who fit the inclusionary and exclusionary criteria.

Article Four: Dias, D., Lains, J., Pereira, A., Nunes, R., Caldas, J. et al. Can we improve gait skills in chronic hemiplegics? A randomized control trial with gait trainer. *Clinic of Physical Medicine and Rehabilitation.* 2007; 43: 499-504

Clinical Bottom Line: In subjects that are one year post-stroke without other impairments that effect walking, there is questionable evidence to say that NDT is no better than using a gait trainer in increasing BBS, Rivermead Mobility Index (RMI), six min. test, and step length and cadence scores after 40 minute

sessions five times a week for five weeks. Step length and step cadence continued to improve three months post-treatment in the NDT group, while the BBS improved in the gait trainer group. The internal validity was deemed good with the only threats being the Rosenthal and Hawthorne effects. However, the external validity was poor as subjects were one year or greater after stroke, the study did not mention how many participants were needed to show power, and no between group comparisons were made. The treatments seem to exceed insurance reimbursement but the time constraints were manageable in both groups for the patients and the therapists.

Article Four PICO:

Population: This study included 40, 18-80 year olds who had been diagnosed with their first stroke over one year prior to the study commencement and who had no rehabilitation in the past six months.

Intervention: Participants were treated for 40 minutes, five times a week for five weeks with 20 minutes of NDT and 20 minutes of stretching and strengthening.

Comparison: The control treatment received gait training with REHA-STIM trainer for 20 minutes, five times a week for five weeks with 20 minutes of stretching and strengthening.

Outcomes: This study evaluated the participants' progress with Motricity Index, Toulouse Motor Scale, Modified Ashworth Spasticity Scale, BBS, RMI, Fugl-Meyer Stroke Scale, Functional Ambulation Category, and Step

test. The BBS, RMI, 10 MWT, and six min. test were relevant to my review and are presented in the following paragraphs.

Blinding: This was a single blind study with only the assessors unaware of the participants' allocation. This serves as a minor threat since the therapist might have treated the patients in the groups differently because they knew what the hypothesis was. Also the patients knew which treatment they were getting and their motivation may have been effected.

Controls: The control group received part of their therapy on the REHA- STIM trainer. It consists of two footplates that the patient stands on that simulate swing and stance phase of gait with a harness that suspends the patient. A motor assists in movement by regulating the velocity and center of mass of the patient. The patient's body weight was never suspended greater than 30% and was reduced in subsequent sessions. A physical therapist was needed to correct knee motion when necessary. The second half of the treatments consisted of joint mobilization and muscular strengthening.

Randomization: The participants were placed into their group by permuted-block randomization. Only an administrative secretary knew of the allocation of the patients, the researchers did not. The randomization was successful as the groups were similar at baseline.

Study: This was a randomized control trial with assessor blinding including 20 participants in both the experimental group and the treatment group. The inclusion / exclusion criteria were a first time stroke, chronic stage with 12 months since onset, motor stabilization, lower limb motor deficit, between the

ages of 18-80, cognitive state of greater than 19 on the mini mental state exam, communication skills necessary to understand treatment, absence of other medical conditions that would interfere with test results, and no rehabilitation management in the previous six months.

The experimental group, NDT group, received 40 minutes of treatment five times a week for five weeks. The first 20 minutes of their sessions included NDT focused gait training and balance exercises. The remaining 20 minutes included similar joint mobilizations and muscular strengthening as the control group received. The control group, trainer group, treatment was as described above. Outcome measures: The authors reported that the RMI, BBS, 10 MWT, and six min. test have all been found to be reliable and valid although no inter-rater or intra- rater reliability was reported. There is no gold standard for measuring balance or gait abilities. The RMI is an extension of the RMA gross motor section that was utilized in an earlier in this paper. Included in the RMI are 15 items scored from zero (unable to perform), to one (being able to perform). On an independent search, it was found to have a MDC of 2.2 points (Rehabilitation Measures Database, 2010). As discussed earlier, the BBS has a fall risk cut off score of 45/56 with an MDC that varies depending on their initial score, but is around three. The 10 MWT MCID for velocity is .16 m/s; no data could be found on cadence. The 6 min. test MCID has been found to be a 50 meter increase. Study losses: The article does not report any study losses. No data appears to be missing. There was no intention to treat analysis performed. All subjects were evaluated in the group they were originally randomized into.

Summary of Internal Validity: The internal validity was judged to be good. The study was randomized, controlled, single blind, and the subjects were similar at baseline. There was no intention to treat performed, but that is not a threat as no participants were lost. The only minor threats to the validity are the Rosenthal and Hawthorne effects because the therapists and patients where not blinded. It is very difficult to avoid these threats in physical therapy research. No power analysis was performed, therefore it is unknown if a change will be detected with statistical tests even if one is truly exists.

Evidence: The two groups were analyzed using T tests. The researchers only reported within group changes and did not present data that did not have significant results at either initially post-treatment or at three months post-treatment. From a visual inspection, there does not appear there would be any between group differences. Table 11 outlines the relevant outcomes for the NDT group and Table 12 for the gait trainer group.

Table 11. NDT group change scores after five weeks of treatment, and three months after treatment ended with T- Test results. X indicates no significance.

	Post Treatment Change Score	T- Test	3 months Change Score	T- Test
BBS	3.42 +/- 6.69	.039	1.42 +/- 4.00	x
RMI	1.26 +/- 1.82	.007	.16 +/- .90	x
Step cadence	.01 +/- .15	x	14.94 +/- 23.20	.017
Step length	2.11 +/-18.51	.017	18.52 +/- 29.41	.019
6 min test	23.28 +/- 2.33	.001	.56 +/- 22.65	x

The NDT group had significant within group changes in the BBS, RMI, step length, and 6 min. test initially after treatment. There were no differences found for velocity or step cadence initially. However, step cadence and step length were significantly different at three months post-treatment compared to

initially post-treatment. None of the outcomes reached a significant MCID. The gait trainer group had significant results in all categories following the five-week treatment. However, only the BBS score improved significantly three months after treatment cessation. None of the outcome tools reached their MCID.

Table 12. Gait Trainer group change scores after five weeks of treatment, and three months after treatment ended with T- Test results. X indicates no significance.

	Post Treatment Change score	T- Test	Three months change score	T- Test
BBS	3.90 +/- 6.53	.015	1.65 +/- 1.90	.001
RMI	.35 +/- .75	.049	1.35 +/- 3.38	x
Step cadence	11.06 +/- 23.84	.041	16.52 +/- 47.12	x
Step length	13.33 +/- 21.88	.013	18.50 +/- 45.03	x
6 min. test	18.92 +/- 26.33	.005	9.88 +/- 34.80	x

Applicability of study results:

Benefits vs. Cost: Both groups received dosage-matched treatments. The number of treatments was high in this study with the least amount of change in the groups' outcome scores compared to other articles reviewed. The financial costs of the trainer is quite high, as discussed with the body weight supported treadmill training. The treadmill training does not require extra certification unlike NDT. The cost to become a certified NDT therapist requires significant time on the therapist. There were no adverse events reported in either of the treatment groups.

Feasibility of treatment: The NDT treatments were not well described and would be difficult to reproduce. The gait training was outlined clearly and would be easier to follow. The total of 25 sessions is beyond the average initially approved 12 sessions by Medicare for outpatient therapy (Centers for Medicare and Medicaid Services, 2014). This estimate is based off the average cost of therapy

at 90 dollars a session (Edgar, 2011), and the therapy cap of 1,920 dollars that is split between Speech-Language Pathology for a calendar year (Centers for Medicare and Medicaid Services, 2014). However, 40 minutes is feasible for both the therapist and the patient. There is no reliance on a home exercise program. The treatments were not painful.

Summary of external validity: The external validity was deemed to be fair. There was questionable power due to the fact there was no power analysis performed for this study. This study had a limited ability to assist in answering the question in the clinical question. The participants all had a diagnosis of chronic stroke, and therefore are very much unlike the patient in the clinical scenario. Otherwise the study had high enough internal validity to be extrapolated to patients who have had a stroke over a year, as there was a strict protocol for the study and appropriate statistical tests were used.

Synthesis:

Based on the results of the reviewed research studies, in patients two weeks post stroke diagnosis, it appears NDT is equally effective at improving gait and pre-gait abilities as other physical therapy interventions such as task practice and standard gait training. The results support this conclusion as two of the four studies reviewed found a lack of between group differences and the other two studies failed to reveal anything more than scattered significant differences between the groups in various outcome assessments.

The Vliet et al. study was strong because it contained the highest number of subjects who were most comparable to the patient in the clinical scenario in

length of time elapsed since stroke diagnosis. This study also provided a total number of treatments most similar to the number allowed in our present healthcare reimbursement environment. The Eich et al. study had the highest quality methodology based on its PEDro score. The duration of each individual treatment session was also most comparable to average treatment times provided in an acute rehabilitation setting. The Brock et al. study had the least number of subjects and the fewest total number of treatment sessions. The subjects were, however, treated for two weeks which is very comparable to a typical length of stay for an acute rehab stroke patient. The Dias et al. study appears to be the weakest study in the review due to their subjects, treated one-year post stroke diagnosis, being the least like the patient in the clinical scenario. According to its PEDro score, it also had the poorest quality methodology.

Each study provided different treatments to their non-NDT comparison group that limits one's ability to draw a cumulative conclusion on the effectiveness of NDT over other physical therapy interventions. All the comparison group interventions were, however, typical treatment approaches commonly considered to be components of standard physical therapy geared toward improving gait and pre-gait functions. Therefore, the variety of treatments provided is deemed sufficient to reveal the comparative efficacy of the NDT approach for rehabilitation.

In the reviewed studies, the most common flaw was an imprecise description of the treatments provided to comparison group subjects. The studies' descriptions were insufficient to allow additional researchers to validly duplicate

or challenge their results and findings. Internal validity of these types of research studies would improve if appropriate methods of blinding both patients and therapists could be accomplished. Since each of these studies had a low number of participants, the strength of their research would be improved if they had investigated a greater number of subjects or performed a power analysis to ensure if enough participants were tested. Future research could focus on standardizing a quality of gait assessment as attempted by Eich et al. using Rancho Los Amigos scale.

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